

JSC TOXICOLOGY GROUP

Valerie Meyers, Ph.D., DABT
NASA JSC/SK4
Houston, TX 77058

**Memorandum Number****TOX-VM-2014-06**

Voice: (281) 483-4989
Fax: (281) 483-3058
valerie.e.meyers@nasa.gov

DATE: August 27, 2014

SUBJECT: Toxicological Assessment of ISS Air and Water Quality: March 2014 – May 2014 and SpaceX-3 First Ingress (Increment 39)

SUMMARY: Based on these limited data, air quality was nominal on ISS for this period, and potable water remains acceptable for crew consumption.

AIR QUALITY

Five mini grab sample containers (mGSCs) were collected on ISS during Increment 39 and were returned on 37S. Of these, 4 were collected as routine archive samples, and 1 was collected during SpaceX-3 (SpX-3) first ingress. Due to the insights provided by the operational use of the air quality monitor on ISS, routine archive sample numbers have been reduced from 3 per month to 2 per month. A sample is collected every month in the US Laboratory (Lab), and the remaining sample is now rotated between the Japanese Pressurized Module (JPM), the Columbus Module (Col), and the Russian Service Module (SM). Two pairs of passive-diffusion formaldehyde badges were also deployed in the US Lab and SM in March and April and were returned aboard 37S. A summary of the analytical results is provided in Table 1.

Table 1. Analytical Summary of ISS air analyses

Sample Location	Sample Date	NMVOCs ^a (mg/m ³)	Freon 218 (mg/m ³)	Alcohols ^b (mg/m ³)	T-Value ^c (units)	CO ₂ (mg/m ³)	Formaldehyde (µg/m ³)
Lab	3/31/2014	17	2.9	14	0.4	7700	39
JPM	3/31/2014	16	2.7	13	0.4	6600	--
SM	3/31/2014	--	--	--	--	--	28
SpX-3	4/21/2014	14	2.5	11	0.2 ^d 0.5	6900	--
Lab	4/28/2014	14	2.5	11	0.4	7300	70
Col	4/28/2014	14	2.8	11	0.4	7100	--
SM	4/28/2014	--	--	--	--	--	27
Guideline		<25	---	<5	<1 ^e	<9300	<120

^aNon-methane volatile organic hydrocarbons, excluding Freon 218

^bIncludes acetone

^cSum of the ratios of the measured concentration and the corresponding 180-day SMAC for each compound, excluding CO₂

^dValue based on 7-day SMACs used for evaluating first ingress.

^eT-value <1 used to evaluate routine monthly sampling; T-value <3 used to evaluate first ingress samples

Complete data tables of all measured concentrations and corresponding T-values based on 180-day SMACs are enclosed. A data table containing T-values based on both the 7-day and 180-day SMACs is also enclosed for the SpX-3 first ingress sample. The detection limit for all target compounds was 0.025

mg/m³, with the exception of m/p-xylenes and hexachloro-1,3-butadiene, which was 0.05 mg/m³. The average recoveries of the 3 surrogate standards from the mGSCs were as follows: ¹³C-acetone, 119 ± 4%; fluorobenzene-d₅, 109 ± 5%; and chlorobenzene-d₅, 98 ± 3%. For the passive-diffusion formaldehyde badges, positive control recoveries (1 trip and 2 lab controls) were 106%, 128%, and 105%, respectively.

The Air Quality Monitor (AQM) is now operational and certified for use in the US Lab, Columbus, and JEM. Two AQM units, with different gas chromatographic columns operate simultaneously on ISS. During Increment 39, an air quality survey was initiated to evaluate variability in air quality throughout the ISS stack. The plan is for one AQM to remain in the US Lab while the other unit is rotated between the US Lab, Col, and JEM every 2 months. During Increment 39, both AQM units were located in the US Lab until 4/8/2014 when one unit (S/N 1003) was moved to Col. The AQM units have automated sampling sessions scheduled every 73 hours, which results in 2-3 sampling sessions per week. Data are transferred to the ground weekly. Monthly average concentrations for Increment 39 are presented in Table 2.

Table 2. Average monthly concentrations (mg/m³) of AQM target compounds.

	March	April	May	Increment Average
2-Propanol	0.14	0.15	0.17	0.15
Methanol	0.38	0.37	0.39	0.38
Acetone	0.20	0.24	0.27	0.24
1,2-Dichloroethane	ND	ND	ND	ND
Hexanal	ND	ND	ND	ND
Acrolein	ND	ND	ND	ND
Hexane	ND	ND	ND	ND
Benzene	ND	ND	ND	ND
Acetaldehyde	0.13	0.15	0.16	0.15
o-Xylene	0.06	0.07	Trace	0.06
OMCTS	Trace	Trace	Trace	Trace
DMCPS	2.2	1.85	1.76	1.94
HMCTS	1.8	1.75	1.94	1.83
Ethanol	3.3	4.25	4.99	4.18
n-Butanol	0.12	0.14	0.17	0.14
Trimethylsilanol	0.28	0.31	0.32	0.31
Ethyl Acetate	0.07	0.21	0.11	0.14
Toluene	Trace	ND	ND	ND
Dichloromethane	0.05	0.05	0.05	0.05
m,p-Xylenes	ND	ND	ND	ND
2-butanone	Trace	Trace	Trace	Trace

Toxicological Evaluation of ISS Air Quality

Routine sampling: Routine monthly mGSC sampling provides a very limited set of samples on which to perform an air quality assessment, but is complementary to in-flight air monitoring data collected by the air quality monitor (AQM). T-values for all routine samples (mGSC and AQM) collected during Increment 39 were below 1 in all locations, indicating no concern for crew health. Increment T-values from mGSCs (Table 1 and Figure 1) and the AQM (Figure 2) correlate well, with average total values between 0.4 – 0.5 units. Primary contributors to the total T-value across all routine sampling locations throughout this time period were hexamethylcyclotrisiloxane, acetaldehyde, decamethylcyclopentasiloxane, and trimethylsilanol. The siloxane/silanol compounds were measured well below levels of

health concern but may contribute to periodic accumulation of these compounds in the water recovery system (see Water Quality section below).

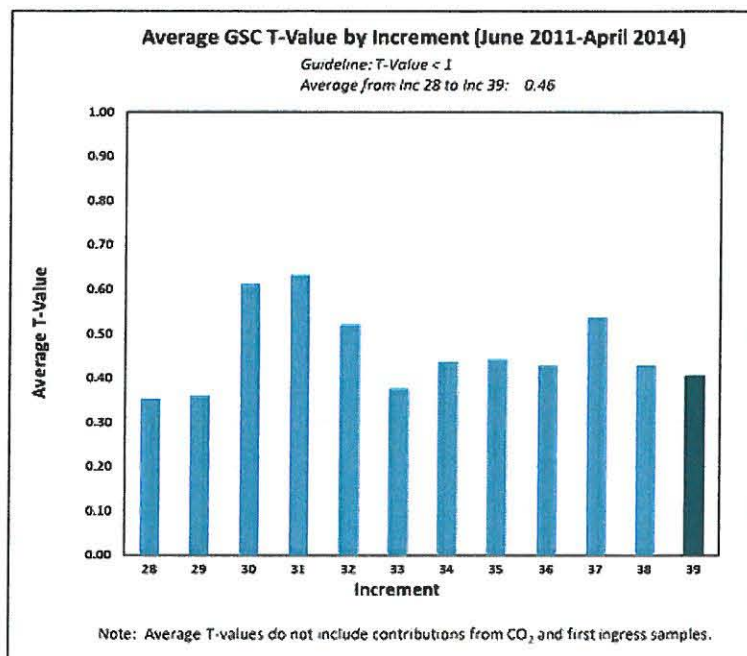


Figure 1. GSC T-values

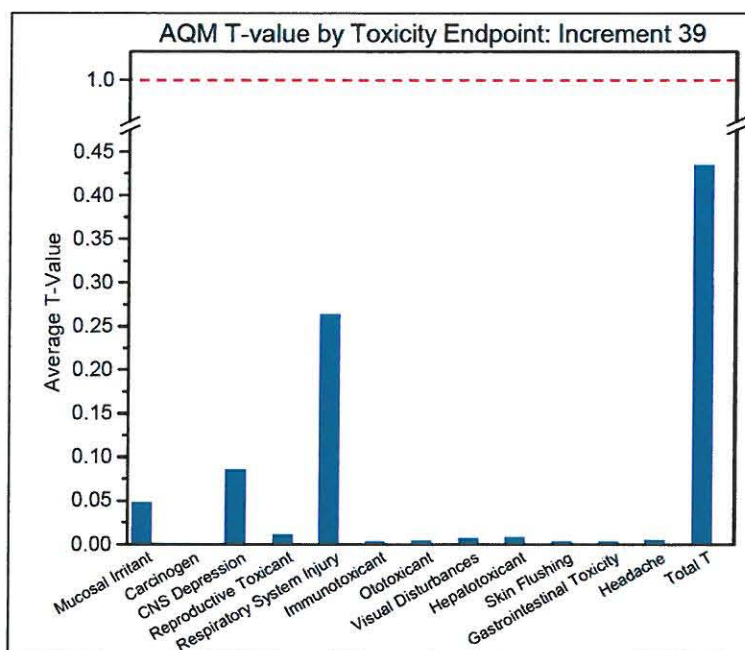


Figure 2. AQM T-values

The mGSCs provide only a snapshot of conditions and are not ideal for evaluating potential CO₂ exposures; however, reported levels were below 4 mmHg (9300 mg/m³), as requested for this Increment in Chit 012152. **Notably, alcohol values in all routine monthly samples exceed the alcohol guideline of <5 mg/m³, which is intended to protect the water recovery system from risk of overloading.** These levels are primarily due to a recent, sustained increase in ethanol levels on ISS. We are unaware of any

new sources of ethanol and are working with our ECLS colleagues to determine impacts to the system. Formaldehyde levels in the US Lab (shown in Table 1 and Figure 3) are generally consistent with historic levels. Concentrations in the US Lab in late April were higher than expected, but all levels are below the SMAC of 120 $\mu\text{g}/\text{m}^3$. We are working to investigate potential sources of this observed increase.

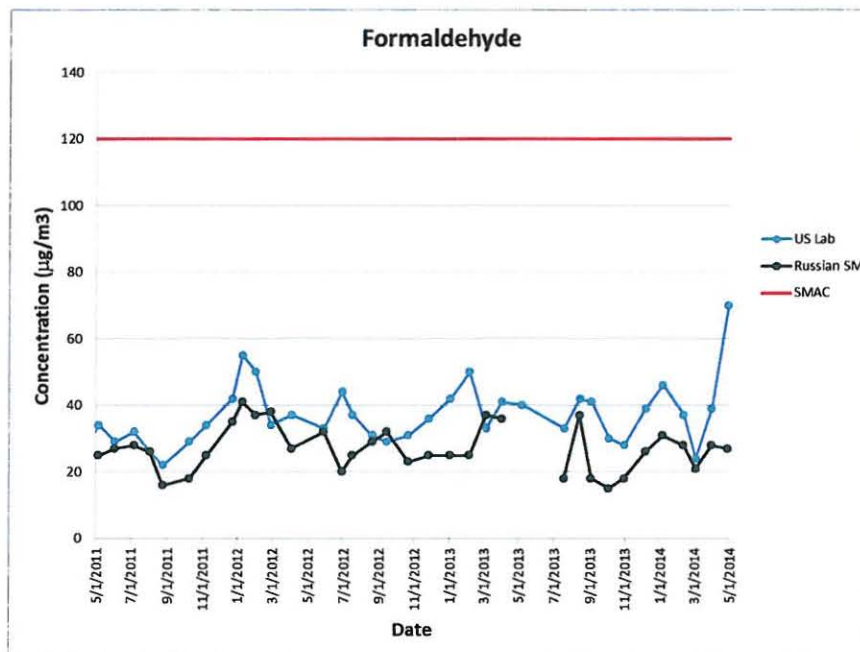


Figure 3. Formaldehyde trending in ISS air.

SpX-3 First Ingress: The predicted T-value was 0.6 units based on the pre-flight off-gas test (0.12 units/day x 4 days). The measured T-value on ISS was 0.2 units. However, the CO₂ and Freon 218 levels measured in the SpX-3 first ingress sample indicate that nearly complete mixing occurred with the ISS atmosphere prior to sample collection. The sample was collected 18 minutes after hatch opening and 11 minutes after intermodular ventilation (IMV) was established. Therefore, the results of the collected sample are not fully representative of contaminant levels at first ingress. A similar delay occurred for Orb-1 (to be reported when samples return on 38S). As a result, we are in discussions with console and training to determine how to prevent these delays in the future.

WATER QUALITY

Archive samples were collected from the potable water dispenser (PWD) in the US Lab during Increment 39 and were returned on 37S. A summary of the analytical results from those samples is provided in Table 2. Complete data tables for the water analyses are found in analytical chemistry report #2014-WFL-ISSWQ-005.1. Water samples from the Russian Segment were not collected during this Increment due to the contingency EVA conducted on 4/23 to replace an external multiplexer/demultiplexer (EXT-2 MDM), a computer that controls critical ISS functions.

Table 2. Analytical Summary of ISS water analyses

Sample Location	Sample Date	TOC (mg/L)	DMSD (mg/L)	Conductivity (µS/cm)	Total Iodine (mg/L)
PWD (ambient)	3/31/2014	0.14	<0.5	2	<0.05
PWD (hot)	5/6/2014	0.18	<0.5	2	<0.05
Guideline		<3	<35	--	<0.2

^aRussian water system is intentionally mineralized.

Toxicological Evaluation of ISS Water Quality: Routine monthly sampling provides a very limited set of samples on which to perform a water quality assessment; however, data from archive samples complement the in-flight monitoring data collected by the total organic carbon analyzer (TOCA) and the colorimetric water quality monitor kit (CWQMK). Total organic carbon (TOC) trending data from in-flight and archival sampling of the US potable water system are shown in Figure 4. TOC levels during Increment 39 were below detection (285 µg/L). No measured compounds in archive samples exceeded MORD limits, indicating no concern for crew consumption.

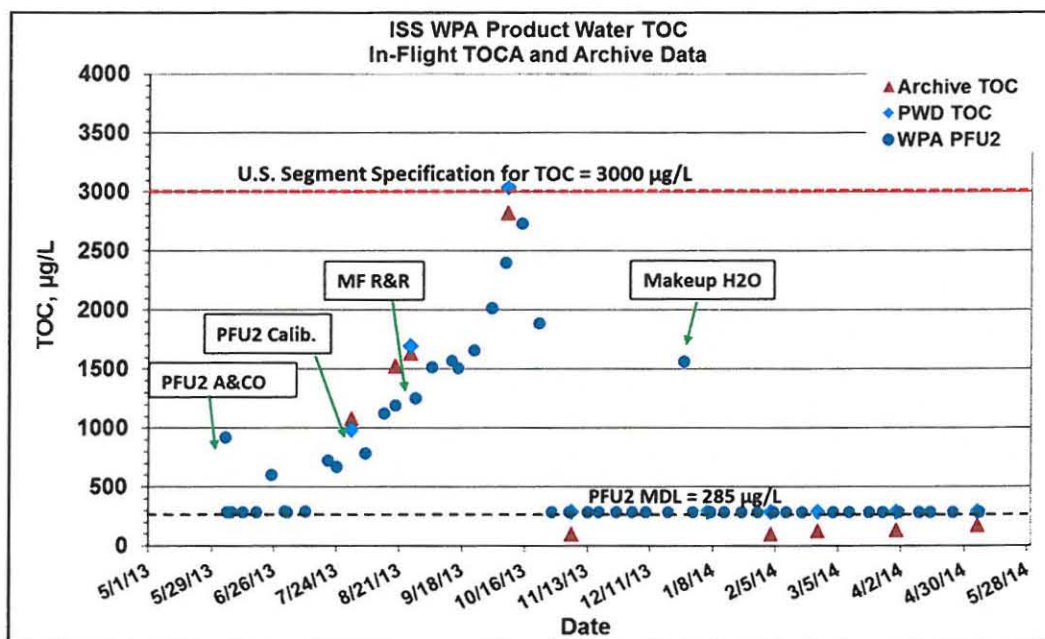


Figure 4. Total Organic Carbon (TOC) trending in US Potable Water

Conductivity provides an indirect measure of the amount of total inorganic contaminants. Inorganic levels in US water were very low, as expected. Iodine is added as a biocide to the water produced by the US water processor assembly (WPA) but is removed prior to crew consumption to avoid potential thyroid damage. Total iodine levels measured in the US water samples were below levels of concern for crew consumption. See the Soyuz 37 post-flight report issued by the Environmental Microbiology Group for additional information on the results from microbial analyses run on the samples.

Valerie Meyers
 Valerie Meyers, Ph.D., DABT
 NASA Toxicologist

8/27/2014
 Date

Enclosures Table 1: Analytical concentrations of compounds found in the mGSCs returned on 37S
 Table 2: T-values corresponding to analytical concentrations in Table 1, based on 180-day SMACs
 Table 2A: T-values corresponding to the analytical concentrations in Table 1, based on 180-day and 7-day SMACs for SpX-3 first ingress

TABLE 1
ANALYTICAL RESULTS OF
37S RETURN/SPX-3 INGRESS GSC AIR SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M ³)				
	AA05739 S/N 2069 LAB	AA05740 S/N 2064 JPM	AA05734 S/N 2060 SpX-3 INGRESS	AA05741 S/N 2061 LAB	AA05742 S/N 2067 COL
	3/31/14 @ 09:47 GMT	3/31/14 @ 09:48 GMT	4/21/14 @ 08:20 GMT	4/28/14 @ 14:05 GMT	4/28/14 @ 14:06 GMT
TARGET COMPOUNDS (TO-15)					
FREON12	<0.025	<0.025	<0.025	<0.025	<0.025
CHLOROMETHANE	<0.025	<0.025	<0.025	<0.025	<0.025
FREON114	<0.025	<0.025	<0.025	<0.025	<0.025
METHANOL	0.49	0.45	0.53	0.52	0.55
ACETALDEHYDE	0.30	0.27	0.22	0.30	0.27
VINYLCHLORIDE	<0.025	<0.025	<0.025	<0.025	<0.025
BROMOMETHANE	<0.025	<0.025	<0.025	<0.025	<0.025
ETHANOL *	13	12	9.1	9.7	9.8
CHLOROETHANE	<0.025	<0.025	<0.025	<0.025	<0.025
ACETONITRILE	<0.025	<0.025	<0.025	<0.025	<0.025
PROPENAL	<0.025	<0.025	<0.025	<0.025	<0.025
ACETONE	0.42	0.38	0.44	0.49	0.48
PROPANAL	0.062	0.059	0.065	0.067	0.070
ISOPROPANOL	0.18	0.15	0.54	0.18	0.15
FREON11	<0.025	<0.025	<0.025	<0.025	<0.025
FURAN	<0.025	<0.025	<0.025	<0.025	<0.025
ACRYLONITRILE	TRACE	<0.025	<0.025	TRACE	<0.025
PENTANE	<0.025	<0.025	<0.025	<0.025	<0.025
2-METHYL-2-PROPANOL	TRACE	TRACE	TRACE	TRACE	TRACE
METHYLACETATE	0.083	0.070	0.063	0.035	0.039
1,1-DICHLOROETHENE	<0.025	<0.025	<0.025	<0.025	<0.025
DICHLOROMETHANE	<0.025	<0.025	0.11	TRACE	TRACE
3-CHLOROPROPENE	<0.025	<0.025	<0.025	<0.025	<0.025
FREON113	<0.025	<0.025	<0.025	<0.025	<0.025
N-PROPANOL	0.036	0.037	0.034	0.030	0.042
1,1-DICHLOROETHANE	<0.025	<0.025	<0.025	<0.025	<0.025
BUTANAL	<0.025	<0.025	TRACE	<0.025	<0.025
2-BUTANONE	TRACE	TRACE	0.069	TRACE	0.026
CIS-1,2-DICHLOROETHENE	<0.025	<0.025	<0.025	<0.025	<0.025
2-METHYLFURAN	<0.025	<0.025	<0.025	<0.025	<0.025
ETHYLACETATE	0.14	0.12	0.21	0.13	0.14
HEXANE	<0.025	<0.025	<0.025	<0.025	<0.025
CHLOROFORM	<0.025	<0.025	<0.025	<0.025	<0.025
2-BUTENAL	<0.025	<0.025	<0.025	<0.025	<0.025
1,2-DICHLOROETHANE	TRACE	TRACE	TRACE	TRACE	TRACE
1,1,1-TRICHLOROETHANE	<0.025	<0.025	<0.025	<0.025	<0.025
N-BUTANOL	0.075	0.072	0.16	0.075	0.085
BENZENE	<0.025	<0.025	<0.025	<0.025	<0.025
CARBONTETRACHLORIDE	<0.025	<0.025	<0.025	<0.025	<0.025
2-PENTANONE	<0.025	<0.025	<0.025	<0.025	<0.025
2-METHYLHEXANE	<0.025	<0.025	TRACE	TRACE	TRACE
2,3-DIMETHYLPENTANE	<0.025	<0.025	TRACE	TRACE	TRACE
PENTANAL	<0.025	<0.025	<0.025	<0.025	<0.025
3-METHYLHEXANE	TRACE	TRACE	0.047	0.047	0.051
1,2-DICHLOROPROPANE	<0.025	<0.025	<0.025	<0.025	<0.025
1,4-DIOXANE	<0.025	<0.025	<0.025	<0.025	<0.025
TRICHLOROETHENE	<0.025	<0.025	<0.025	<0.025	<0.025
2,5-DIMETHYLFURAN	<0.025	<0.025	<0.025	<0.025	<0.025
N-HEPTANE	<0.025	<0.025	TRACE	TRACE	TRACE
4-METHYL-2-PENTANONE	<0.025	<0.025	TRACE	<0.025	<0.025
CIS-1,3-DICHLOROPROPENE	<0.025	<0.025	<0.025	<0.025	<0.025
2-PENTENAL	<0.025	<0.025	<0.025	<0.025	<0.025
TRANS-1,3-DICHLOROPROPENE	<0.025	<0.025	<0.025	<0.025	<0.025
1,1,2-TRICHLOROETHANE	<0.025	<0.025	<0.025	<0.025	<0.025
TOLUENE	0.030	0.031	0.073	0.036	0.040
HEXANAL	<0.025	<0.025	<0.025	<0.025	<0.025
MESITYLOXIDE	<0.025	<0.025	<0.025	<0.025	<0.025
1,2-DIBROMOETHANE	<0.025	<0.025	<0.025	<0.025	<0.025
BUTYLACETATE	<0.025	<0.025	TRACE	<0.025	<0.025
OCTANE	<0.025	<0.025	<0.025	<0.025	<0.025
TETRACHLOROETHENE	<0.025	<0.025	<0.025	<0.025	<0.025
CHLOROBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025
ETHYLBENZENE	<0.025	<0.025	0.042	<0.025	<0.025
M/P-XYLENES	<0.050	<0.050	0.11	<0.050	<0.050
2-HEPTANONE	<0.025	<0.025	<0.025	<0.025	<0.025
CYCLOHEXANONE	<0.025	<0.025	<0.025	<0.025	<0.025
HEPTANAL	<0.025	<0.025	<0.025	<0.025	<0.025
STYRENE	<0.025	<0.025	<0.025	<0.025	<0.025
1,1,2,2-TETRACHLOROETHANE	<0.025	<0.025	<0.025	<0.025	<0.025
O-XYLENE	0.059	0.057	0.11	0.074	0.080
NONANE	<0.025	<0.025	<0.025	<0.025	<0.025
1,3,5-TRIMETHYLBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025
1,2,4-TRIMETHYLBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025
1,3-DICHLOROBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025
1,4-DICHLOROBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025
1,2-DICHLOROBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025
1,2,4-TRICHLOROBENZENE	<0.025	<0.025	<0.025	<0.025	<0.025
HEXACHLORO-1,3-BUTADIENE	<0.050	<0.050	<0.050	<0.050	<0.050

TABLE 1
ANALYTICAL RESULTS OF
37S RETURN/SPX-3 INGRESS GSC AIR SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M ³)				
	AA05739 S/N 2069 LAB	AA05740 S/N 2064 JPM	AA05734 S/N 2060 SpX-3 INGRESS	AA05741 S/N 2061 LAB	AA05742 S/N 2067 COL
	3/31/14 @ 09:47 GMT	3/31/14 @ 09:48 GMT	4/21/14 @ 08:20 GMT	4/28/14 @ 14:05 GMT	4/28/14 @ 14:06 GMT
SPECIAL INTEREST COMPOUNDS **					
1,3-BUTADIENE &&	<0.025	<0.025	<0.025	<0.025	<0.025
ETHYLENE OXIDE	<0.050	<0.050	<0.050	<0.050	<0.050
2-METHYL-2-PROPENAL	<0.050	<0.050	<0.050	<0.050	<0.050
3-BUTEN-2-ONE	<0.050	<0.050	<0.050	<0.050	<0.050
2-ETHOXYETHANOL	<0.050	<0.050	<0.050	<0.050	<0.050
DIMETHYL DISULFIDE	<0.050	<0.050	<0.050	<0.050	<0.050
OCTAFLUOROPROPANE &	2.9	2.7	2.5	2.5	2.8
PERFLUORO-2-METHYLPENTANE &	<0.050	<0.050	<0.050	<0.050	<0.050
CARBONYL SULFIDE &	<0.025	<0.025	<0.025	<0.025	<0.025
ISOBUTANE &	<0.025	<0.025	TRACE	TRACE	<0.025
2-METHYL-1-PROPENE &	TRACE	TRACE	TRACE	TRACE	TRACE
DIMETHYL SULFIDE &	<0.025	<0.025	<0.025	<0.025	<0.025
CARBON DISULFIDE &&	<0.025	<0.025	TRACE	<0.025	<0.025
TRIMETHYLSILANOL &	0.12	0.12	0.21	0.12	0.15
OCTAMETHYLCYCLOTETRAILOXANE &	<0.075	<0.075	0.084	<0.075	TRACE
DECAMETHYLCYCLOPENTASILOXANE &	0.46	0.45	0.34	0.43	0.43
HEXAMETHYLCYCLOTRISILOXANE %	1.4	1.3	1.6	1.2	1.5
NON-TARGET COMPOUNDS **					
PROPENE &&	TRACE	TRACE	TRACE	TRACE	TRACE
PROPANE &&	<0.025	<0.025	<0.025	<0.025	<0.025
BUTANE &&	<0.025	<0.025	<0.025	<0.025	<0.025
ISOPRENE &&	0.075	0.060	0.070	0.066	0.071
1,3-DIOXOLANE	<0.050	<0.050	<0.050	<0.050	TRACE
2-ETHYL-1-HEXANOL	0.11	0.098	0.14	0.093	0.11
LIMONENE	TRACE	TRACE	0.073	0.11	0.12
TOTAL ALCOHOLS PLUS ACETONE	14	13	11	11	11
TARGET COMPOUNDS (GC)					
CARBON MONOXIDE	0.48	0.44	0.55	0.59	0.60
METHANE	2.2	2.2	8.3	8.7	8.8
HYDROGEN	3.7	3.7	4.7	5.7	5.7
CARBON DIOXIDE	7700	6600	6900	7300	7100
TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)	20	18	17	16	17
TOTAL CONCENTRATION - OFP (NON-METHANE HYDROCARBONS)	17	16	14	14	14

* GC/FID data results are in bold

** Quantified using "B" response factor except where noted

& Quantified using a multi-point calibration

&& Quantified using one-point calibration

% Response factor generated from an internal study

<: Value is less than the laboratory report detection limit.

TRACE: Amount detected is sufficient for compound identification only.

OFP - Octafluoropropane

TABLE 2
T-VALUES for 37S RETURN GSC AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)			
	AA05739 S/N 2069 LAB	AA05740 S/N 2064 JPM	AA05741 S/N 2061 LAB	AA05742 S/N 2067 COL
	3/31/14 @ 09:47 GMT	3/31/14 @ 09:48 GMT	4/28/14 @ 14:05 GMT	4/28/14 @ 14:06 GMT
TARGET COMPOUNDS (TO-15)				
FREON12	ND	ND	ND	ND
CHLOROMETHANE	ND	ND	ND	ND
FREON114	ND	ND	ND	ND
METHANOL	0.00544	0.00502	0.00579	0.00608
ACETALDEHYDE	0.07550	0.06710	0.07492	0.06757
VINYLCHLORIDE	ND	ND	ND	ND
BROMOMETHANE	ND	ND	ND	ND
ETHANOL	0.00630	0.00598	0.00485	0.00492
CHLOROETHANE	ND	ND	ND	ND
ACETONITRILE	ND	ND	ND	ND
PROPENAL	ND	ND	ND	ND
ACETONE	0.00816	0.00733	0.00943	0.00924
PROPANAL	0.00568	0.00541	0.00605	0.00635
ISOPROPANOL	0.00120	0.00099	0.00118	0.00099
FREON11	ND	ND	ND	ND
FURAN	ND	ND	ND	ND
ACRYLONITRILE	0.00446	ND	0.00446	ND
PENTANE	ND	ND	ND	ND
2-METHYL-2-PROPANOL	0.00010	0.00010	0.00010	0.00010
METHYLACETATE	0.00069	0.00058	0.00029	0.00032
1,1-DICHLOROETHENE	ND	ND	ND	ND
DICHLOROMETHANE	ND	ND	0.00125	0.00125
3-CHLOROPROPENE	ND	ND	ND	ND
FREON113	ND	ND	ND	ND
N-PROPANOL	0.00037	0.00037	0.00031	0.00043
1,1-DICHLOROETHANE	ND	ND	ND	ND
BUTANAL	ND	ND	ND	ND
2-BUTANONE	0.00042	0.00042	0.00042	0.00087
CIS-1,2-DICHLOROETHENE	ND	ND	ND	ND
2-METHYLFURAN	ND	ND	ND	ND
ETHYLACETATE	0.00077	0.00068	0.00072	0.00077
HEXANE	ND	ND	ND	ND
CHLOROFORM	ND	ND	ND	ND
2-BUTENAL	ND	ND	ND	ND
1,2-DICHLOROETHANE	0.00781	0.00781	0.00781	0.00781
1,1,1-TRICHLOROETHANE	ND	ND	ND	ND
N-BUTANOL	0.00187	0.00180	0.00188	0.00211
BENZENE	ND	ND	ND	ND
CARBONTETRACHLORIDE	ND	ND	ND	ND
2-PENTANONE	ND	ND	ND	ND
2-METHYLHEXANE	ND	ND	0.00104	0.00104
2,3-DIMETHYLPENTANE	ND	ND	0.00104	0.00104
PENTANAL	ND	ND	ND	ND
3-METHYLHEXANE	0.00104	0.00104	0.00395	0.00427
1,2-DICHLOROPROPANE	ND	ND	ND	ND
1,4-DIOXANE	ND	ND	ND	ND
TRICHLOROETHENE	ND	ND	ND	ND
2,5-DIMETHYLFURAN	ND	ND	ND	ND
N-HEPTANE	ND	ND	0.00104	0.00104
4-METHYL-2-PENTANONE	ND	ND	ND	ND
CIS-1,3-DICHLOROPROPENE	ND	ND	ND	ND
2-PENTENAL	ND	ND	ND	ND
TRANS-1,3-DICHLOROPROPENE	ND	ND	ND	ND
1,1,2-TRICHLOROETHANE	ND	ND	ND	ND
TOLUENE	0.00200	0.00206	0.00242	0.00266
HEXANAL	ND	ND	ND	ND
MESITYLOXIDE	ND	ND	ND	ND
1,2-DIBROMOETHANE	ND	ND	ND	ND
BUTYLACETATE	ND	ND	ND	ND
OCTANE	ND	ND	ND	ND
TETRACHLOROETHENE	ND	ND	ND	ND
CHLOROBENZENE	ND	ND	ND	ND
ETHYLBENZENE	ND	ND	ND	ND
M/P-XYLENES	ND	ND	ND	ND
2-HEPTANONE	ND	ND	ND	ND
CYCLOHEXANONE	ND	ND	ND	ND
HEPTANAL	ND	ND	ND	ND
STYRENE	ND	ND	ND	ND
1,1,2,2-TETRACHLOROETHANE	ND	ND	ND	ND
O-XYLENE	0.00158	0.00154	0.00201	0.00215
NONANE	ND	ND	ND	ND
1,3,5-TRIMETHYLBENZENE	ND	ND	ND	ND
1,2,4-TRIMETHYLBENZENE	ND	ND	ND	ND
1,3-DICHLOROBENZENE	ND	ND	ND	ND
1,4-DICHLOROBENZENE	ND	ND	ND	ND
1,2-DICHLOROBENZENE	ND	ND	ND	ND
1,2,4-TRICHLOROBENZENE	ND	ND	ND	ND
HEXACHLORO-1,3-BUTADIENE	ND	ND	ND	ND

TABLE 2
T-VALUES for 37S RETURN GSC AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)			
	AA05739	AA05740	AA05741	AA05742
	S/N 2069 LAB 3/31/14 @ 09:47 GMT	S/N 2064 JPM 3/31/14 @ 09:48 GMT	S/N 2061 LAB 4/28/14 @ 14:05 GMT	S/N 2067 COL 4/28/14 @ 14:06 GMT
SPECIAL INTEREST COMPOUNDS				
1,3-BUTADIENE	ND	ND	ND	ND
ETHYLENE OXIDE	ND	ND	ND	ND
2-METHYL-2-PROPENAL	ND	ND	ND	ND
3-BUTEN-2-ONE	ND	ND	ND	ND
2-ETHOXYETHANOL	ND	ND	ND	ND
DIMETHYL DISULFIDE	ND	ND	ND	ND
OCTAFLUOROPROPANE	0.00003	0.00003	0.00003	0.00003
PERFLUORO-2-METHYLPENTANE	ND	ND	ND	ND
CARBONYL SULFIDE	ND	ND	ND	ND
ISOBUTANE	ND	ND	0.00005	ND
2-METHYL-1-PROPENE	0.00001	0.00001	0.00001	0.00001
DIMETHYL SULFIDE	ND	ND	ND	ND
CARBON DISULFIDE	ND	ND	ND	ND
TRIMETHYLSILANOL	0.03022	0.02974	0.03046	0.03673
OCTAMETHYLCYCLOTETRASILOXANE	ND	ND	ND	0.00313
DECAMETHYLCYCLOPENTASILOXANE	0.03056	0.02975	0.02886	0.02837
HEXAMETHYLCYCLOTRISILOXANE	0.15467	0.14798	0.12944	0.17031
NON-TARGET COMPOUNDS				
PROPENE	0.00029	0.00029	0.00029	0.00029
PROPANE	ND	ND	ND	ND
BUTANE	ND	ND	ND	ND
ISOPRENE	0.02486	0.01990	0.02195	0.02371
1,3-DIOXOLANE	ND	ND	ND	0.00069
2-ETHYL-1-HEXANOL	0.00202	0.00185	0.00176	0.00206
LIMONENE	0.00022	0.00022	0.00100	0.00101
TARGET COMPOUNDS (GC)				
CARBON MONOXIDE	0.02803	0.02601	0.03448	0.03543
METHANE	0.00064	0.00063	0.00248	0.00252
HYDROGEN	0.01083	0.01077	0.01671	0.01677
CARBON DIOXIDE	0.59408	0.50838	0.56237	0.54243
TOTAL T-VALUE	0.99984	0.88381	0.96085	0.98455
TOTAL T-VALUE - CO2	0.40576	0.37542	0.39848	0.44211

ND : Value is less than the laboratory report detection limit.

Note: Number of decimal places in T-Values do not represent significant figures of measurements.

TABLE 2A
T-VALUES for SpX-3 INGRESS GSC AIR SAMPLE

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)	T-VALUE (7-d SMAC)
	AA05734 S/N 2060 SpX-3 INGRESS 4/21/14 @ 08:20 GMT	AA05734 S/N 2060 SpX-3 INGRESS 4/21/14 @ 08:20 GMT
TARGET COMPOUNDS (TO-15)		
FREON12	ND	ND
CHLOROMETHANE	ND	ND
FREON114	ND	ND
METHANOL	0.00594	0.00594
ACETALDEHYDE	0.05566	0.05566
VINYLCHLORIDE	ND	ND
BROMOMETHANE	ND	ND
ETHANOL	0.00456	0.00456
CHLOROETHANE	ND	ND
ACETONITRILE	ND	ND
PROPENAL	ND	ND
ACETONE	0.00837	0.00837
PROPANAL	0.00590	0.00590
ISOPROPANOL	0.00361	0.00361
FREON11	ND	ND
FURAN	ND	ND
ACRYLONITRILE	ND	ND
PENTANE	ND	ND
2-METHYL-2-PROPANOL	0.00010	0.00008
METHYLACETATE	0.00052	0.00052
1,1-DICHLOROETHENE	ND	ND
DICHLOROMETHANE	0.01146	0.00234
3-CHLOROPROPENE	ND	ND
FREON113	ND	ND
N-PROPANOL	0.00035	0.00035
1,1-DICHLOROETHANE	ND	ND
BUTANAL	0.00096	0.00096
2-BUTANONE	0.00230	0.00230
CIS-1,2-DICHLOROETHENE	ND	ND
2-METHYLFURAN	ND	ND
ETHYLACETATE	0.00115	0.00115
HEXANE	ND	ND
CHLOROFORM	ND	ND
2-BUTENAL	ND	ND
1,2-DICHLOROETHANE	0.00781	0.00781
1,1,1-TRICHLOROETHANE	ND	ND
N-BUTANOL	0.00390	0.00195
BENZENE	ND	ND
CARBONTETRACHLORIDE	ND	ND
2-PENTANONE	ND	ND
2-METHYLHEXANE	0.00104	0.00005
2,3-DIMETHYLPENTANE	0.00104	0.00005
PENTANAL	ND	ND
3-METHYLHEXANE	0.00394	0.00019
1,2-DICHLOROPROPANE	ND	ND
1,4-DIOXANE	ND	ND
TRICHLOROETHENE	ND	ND
2,5-DIMETHYLFURAN	ND	ND
N-HEPTANE	0.00104	0.00005
4-METHYL-2-PENTANONE	0.00009	0.00009
CIS-1,3-DICHLOROPROPENE	ND	ND
2-PENTENAL	ND	ND
TRANS-1,3-DICHLOROPROPENE	ND	ND
1,1,2-TRICHLOROETHANE	ND	ND
TOLUENE	0.00486	0.00486
HEXANAL	ND	ND
MESITYLOXIDE	ND	ND
1,2-DIBROMOETHANE	ND	ND
BUTYLACETATE	0.00007	0.00007
OCTANE	ND	ND
TETRACHLOROETHENE	ND	ND
CHLOROBENZENE	ND	ND
ETHYLBENZENE	0.00084	0.00032
M/P-XYLENES	0.00291	0.00148
2-HEPTANONE	ND	ND
CYCLOHEXANONE	ND	ND
HEPTANAL	ND	ND
STYRENE	ND	ND
1,1,2,2-TETRACHLOROETHANE	ND	ND
O-XYLENE	0.00294	0.00149
NONANE	ND	ND
1,3,5-TRIMETHYLBENZENE	ND	ND
1,2,4-TRIMETHYLBENZENE	ND	ND
1,3-DICHLOROBENZENE	ND	ND
1,4-DICHLOROBENZENE	ND	ND
1,2-DICHLOROBENZENE	ND	ND
1,2,4-TRICHLOROBENZENE	ND	ND
HEXACHLORO-1,3-BUTADIENE	ND	ND

TABLE 2A
T-VALUES for SpX-3 INGRESS GSC AIR SAMPLE

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)	T-VALUE (7-d SMAC)
	AA05734 S/N 2060 SpX-3 INGRESS 4/21/14 @ 08:20 GMT	AA05734 S/N 2060 SpX-3 INGRESS 4/21/14 @ 08:20 GMT
SPECIAL INTEREST COMPOUNDS		
1,3-BUTADIENE	ND	ND
ETHYLENE OXIDE	ND	ND
2-METHYL-2-PROPENAL	ND	ND
3-BUTEN-2-ONE	ND	ND
2-ETHOXYETHANOL	ND	ND
DIMETHYL DISULFIDE	ND	ND
OCTAFLUOROPROPANE	0.00003	0.00003
PERFLUORO-2-METHYLPENTANE	ND	ND
CARBONYL SULFIDE	ND	ND
ISOBUTANE	0.00005	0.00005
2-METHYL-1-PROPENE	0.00001	0.00001
DIMETHYL SULFIDE	ND	ND
CARBON DISULFIDE	0.00078	0.00078
TRIMETHYLSILANOL	0.05168	0.05168
OCTAMETHYLCYCLOTETRAILOXANE	0.00696	0.00030
DECAMETHYLCYCLOPENTASILOXANE	0.02272	0.00341
HEXAMETHYLCYCLOTRISILOXANE	0.17577	0.01758
NON-TARGET COMPOUNDS		
PROPENE	0.00029	0.00029
PROPANE	ND	ND
BUTANE	ND	ND
ISOPRENE	0.02328	0.01164
1,3-DIOXOLANE	ND	ND
2-ETHYL-1-HEXANOL	0.00266	0.00266
LIMONENE	0.00063	0.00063
TARGET COMPOUNDS (GC)		
CARBON MONOXIDE	0.03259	0.00879
METHANE	0.00238	0.00238
HYDROGEN	0.01391	0.01391
CARBON DIOXIDE	0.53164	0.53164
TOTAL T-VALUE	0.99674	0.75592
TOTAL T-VALUE - CO2	0.46510	0.22428

ND : Value is less than the laboratory report detection limit.

Note: Number of decimal places in T-Values do not represent significant figures of measurements.